Snap beans, vine crops and tomatoes, in particular, benefit from adequate levels of manganese. If soil test levels are low, broadcast manganese at a rate of 10 lb/acre. If manganese is unavailable due to high soil pH, apply 0.5 lb/acre as a foliar spray. Try two applications about 10 days apart when deficiencies are severe.

Blossom End Rot

Calcium (Ca) deficiency causes this common tomato problem—a rot on the bottom of the fruit (blossom end). The problem can occur in dry weather even if calcium levels in the soil are adequate because plant uptake is limited.

To supply calcium to the soil, use calcium nitrate (a good nitrogen source) or calcium sulfate (also know as gypsum or landplaster). To apply calcium directly to the fruit, spray 4 lb of calcium nitrate or calcium chloride per 100 gallons of water (4 tbsp/gallon water) every 7 to 10 days for at least two to three applications.

Magnesium (Mg) Deficiency

Often seen on tomato, symptoms include interveinal chlorosis of the lower leaves. The problem frequently occurs on sandy soils, where magnesium reserves are limited due to low cation exchange capacity (CEC). Magnesium also tends to leach from these soils.

If lime is needed, dolomitic lime is a good source of magnesium. If lime is not needed and soil magnesium levels are inadequate, apply enough sulfate of potash magnesia (0-0-22, 11% Mg) to provide 20 to 30 lb of magnesium per acre. If magnesium deficiency occurs during the growing season, apply Epsom salts (11% Mg) at a rate of 2 to 4 lb/acre.

Use of Plant Tissue Sampling

You can check to see whether a crop is receiving sufficient nutrients by collecting tissue samples and having them analyzed. Be careful to collect representative samples and provide adequate information about growing conditions. When trying to diagnose a problem, take separate samples from both normal- and abnormal-looking plants, and collect soil samples from each area.

Other Sources of Fertilizer Information

- NCSU Horticultural Leaflets: www.ces.ncsu.edu/depts/hort/hil/veg-index.html
- The current *N.C. agricultural chemicals manual*: ipm.ncsu.edu/agchem/agchem.html
- *Vegetable crop guidelines for the southeastern U.S.*, published by the N.C. Vegetable Growers Association
- *Sustainable practices for vegetable production in the South*: www.cals.ncsu.edu/sustainable/peet/

N.C. Department of Agriculture and Consumer Services

Steve Troxler, Commissioner of Agriculture

NCDA&CS Agronomic Division
Dr. Colleen M. Hudak-Wise, Director

Mailing Address:	**1040 Mail Service Center** **Raleigh, NC 27699-1040**
Physical Address:	**4300 Reedy Creek Road** **Raleigh, NC 27607-6465**
Phone:	**(919) 733-2655**
Web Site:	**www.ncagr.com/agronomi/**

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NOTE 6: Fertilization of Commercial Vegetable Crops

Successful commercial vegetable production depends on the management of many different components, with soil fertility being one of the primary considerations. Following soil test recommendations for lime and fertilizer should produce optimum yields under average climatic conditions as long as other aspects of standard good management are practiced.

Soil testing helps ensure a good economic return for each dollar spent on fertilizer. Following soil test recommendations also helps protect the environment from pollution by excess fertilizer nutrients. This note provides guidance for making soil fertility decisions related to field production of vegetables where plasticulture is not used.

Lime

The NCDA&CS recommends having soil tested every two to three years to determine lime and fertilizer needs. Liming to the target pH for the crop you intend to grow creates favorable conditions for rooting by neutralizing soil acidity and supplying calcium and/or magnesium. Most vegetable crops grow best at a target pH of 6.0, but 6.5 is recommended for tomatoes and for establishment of asparagus.

Two types of lime are commonly available in N.C.: calcium carbonate (calcitic lime) and calcium

magnesium carbonate (dolomitic lime). On coarse-textured (sandy) soils where leaching is a concern or on soils with low levels of magnesium, it is best to use dolomitic lime. Agricultural grade limestone provides maximum reactivity and effectiveness, especially when incorporated into the soil 6 to 8 inches deep in conventional tillage situations.

Nitrogen (N), Sulfur (S) & Potash (K_2O)

Recommended total nitrogen rates depend on the crop (Table 1) and, to some extent, on soil productivity. The timing of the application is very important for efficient use. Good nitrogen sources include calcium nitrate (15.5-0-0), diammonium phosphate (18-46-0), ammonium sulfate (21-0-0) and various nitrogen solutions.

Note: Sodium nitrate (16-0-0) and ammonium nitrate (34-0-0) are also excellent sources, but they will be unavailable soon.

Sulfur helps a plant use nitrogen efficiently so it is not surprising that deficiency symptoms for nitrogen and sulfur (yellow leaves) are similar and often confused. Sulfur deficiency tends to occur on coarse-textured (sandy) soils. Rainfall washes sulfur out of the root zone and into the subsoil, especially on deep sands. Although less likely, levels of plant-available sulfur can also be limiting in organic soils.

The soil test report gives a sulfur recommendation whenever S-I $\leq$ 25. Since sulfur leaches as readily as nitrogen, it may be adequate at the time of the report but be limiting later during the season. Plant tissue analysis can be used in-season to test for sufficiency. Fertilizers that supply sulfur include ammonium sulfate (21-0-0-24), potassium sulfate (0-0-50-18), and sulfate of potash-magnesia (0-0-22-22).

Potash may also be a concern on sandy soils. If tomatoes and peppers are growing on sandy soils where leaching has occurred, it may be beneficial to apply similar amounts of potash and nitrogen at sidedress. If you suspect leaching of nutrients from coarse-textured (sandy) soils, you can use plant tissue tests to find out if supplemental applications of nitrogen, potassium and sulfur are needed.

Table 1. N recommendations (lb/acre) for selected vegetable crops

Crop	Total N Rate	Application Method & Timing	N per Application
Bell pepper	80–130	planting, broadcast	40–50
		1st fruit set, sidedress	40–50
		later in season, if needed	20–30
Cabbage	100–150	planting, broadcast	50–75
		2–3 wks postplant, sidedress	25–50
		late in season, if needed	25–50
Cucumber (field)	80–140	planting, broadcast	40–80
		2 wks postplant	20
		1st vine run	20–40
Irish Potato	100–150	planting, broadcast	50
		4–5 wks postplant, sidedress	50–100
Sweetpotato	60–90	planting	0
		3–4 wks postplant	60–90
Tomato (field)	90–120	planting, broadcast	45–60
		1st fruit set, sidedress	45–60

Boron (B)

Boron is an essential nutrient that plants need in minute quantities. High soil levels can be toxic to plants. Boron is less available to plants when the soil pH is above 6.5; it also tends to leach from sandy soils.

NCDA&CS soil tests do not measure boron, but reports do recommend annual application for certain vegetable crops that are especially sensitive to boron deficiency. These crops include broccoli, brussels sprouts, cabbage, cantaloupe, cauliflower, collards, field cucumbers, okra, peppers, radish, rutabaga, tomato, turnip, and watermelon. In production of asparagus, boron should be applied to the soil every third year.

NCDA&CS recommends a broadcast application of 1 to 2 lb/acre at planting. The lower rate is recommended on coarse-textured (sandy) soils to reduce the risk of toxicity.

Boron can be put out as a foliar application, but timing is very critical to achieve desired results. The recommended rate is 0.2 lb/acre boron in sufficient water for coverage. Apply foliar boron as follows: prior to heading of cole crops, prior to root swell in root crops, and at first bloom for tomatoes and okra.

Special Concerns

Manganese (Mn) Deficiency

Levels of this essential micronutrient are often low in mineral soils of the coastal plain. Because manganese becomes more unavailable as the soil pH increases above 6.3, excessive liming should be avoided.